

**Title:**

Fundamentals of Categorical Neural Semantic Theory

**Organizers:**

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A recently-developed mathematical semantic theory explains the relationship between knowledge and its representation in connectionist systems. The semantic theory is based upon category theory, the mathematical theory of structure. A product of its explanatory capability is a set of principles to guide the design of future neural architectures and enhancements to existing designs. We claim that this mathematical semantic approach to network design is an effective basis for advancing the state of the art. The topic of this tutorial will be the categorical neural semantic theory (CNST) and its application. We believe that this formal mathematical approach will equip researchers and practitioners in this field to advance the state of the art by 1) thinking about neural networks in new ways, 2) improving the functionality of existing neural networks, and 3) designing new neural architectures. After motivating the topic, we will start with a solid tutorial on the fundamentals of category theory assuming the participant knows nothing of this mathematics. All new mathematical concepts involved in the CNST will be introduced in the tutorial so that a basic engineering mathematics background will be sufficient. Next, we will introduce the CNST in detail, making the connection between category theory and neural architectures, processing, and learning and memory. We will illustrate the CNST by presenting examples of theory-inspired architectures and applications throughout the tutorial. The applications will be drawn from engineering and cognitive psychology. No “hands-on” exercises are planned, although active class discussions will be encouraged.